FCC – OET
White Spaces Meeting

Shure Incorporated
29 January 2008
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LEGENDARY
PERFORMANCE™

Agenda

- Google burst tests
- Shure demonstrations
- OET Lab wireless microphone testing and schedule
- Field testing

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In Ex Parte of Dec. 4, 2007, Google claims[1]…

"Short burst transmissions interact well with existing burst error correction in DTVs and FM modulation in wireless mics."

"FM is inherently burst noise tolerant."

"Tests confirm the same burst transmission scheme is also effective for wireless mics."

These claims are being made by Google in order to allow unlicensed devices to transmit on TV channels before the channel is determined to be free for use, thereby increasing the likelihood of interference to TV and microphones.

[1] Google ex parte filing, Dec. 4, 2007, ET. 04-186

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Shure tests

Shure has conducted several tests that demonstrate the audible and visible interference associated with the Google tests of Dec. 4, 2007, where Google claims no interference to microphones exists.

These test results will be demonstrated in this meeting via audio sound clips and visual waveform plots captured from a digital oscilloscope.

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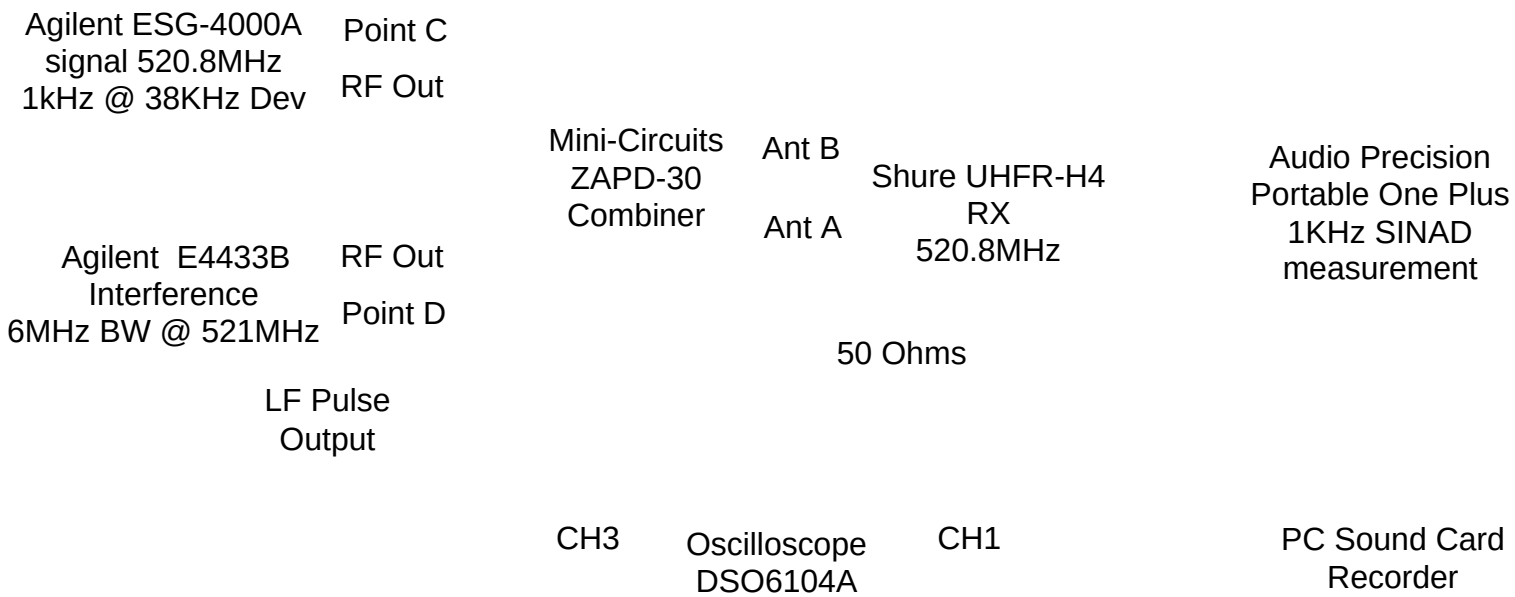
Shure burst test setup

Setup a test that demonstrates the audible interference from Unlicensed Devices at the Google baseline S/N and other points observed under normal microphone operation



Insertion loss from Point C/D to Ant B is 5.2dB

Google tests

Pick one point within the Google test profile for wireless microphone demonstration and use this as the baseline S/N

Google baseline test S/N

Mic Signal at Rx (dBm, -3dB)			-77.9	-56.1	-26.7	-77.9	-56.1	-26.7	-77.9	-56.1	-26.7
Pulse Dur. (us)	Pulse Per. (us)	DC (%)	Interferer (dBm, -3dB)			Burst S/N (dB)			Delta from cont.		
1000	1000	100	-78.5	-57	-29	0.6	0.9	2.3	0	0	0
200	2000	10	-70	-49	-19	-7.9	-7.1	-7.7	8.5	8	10
100	2000	5	-69	-47	-19	-8.9	-9.1	-7.7	9.5	10	10
52	2000	2.6	-67.5	-46	-17	-10.4	-10.1	-9.7	11	11	12
36	2000	1.8	-67	-46	-17	-10.9	-10.1	-9.7	11.5	11	12
20	2000	1	-67	-45	-17	-10.9	-11.1	-9.7	11.5	12	12
36	1000	3.6	-68	-47	-18	-9.9	-9.1	-8.7	10.5	10	11
36	2000	1.8	-67	-46	-17	-10.9	-10.1	-9.7	11.5	11	12
36	4000	0.9	-66	-45	-16	-11.9	-11.1	-10.7	12.5	12	13

40dB SINAD

Table from Google ex parte (Dec. 4, 2007), “Results of burst transmission tests for wireless mics”

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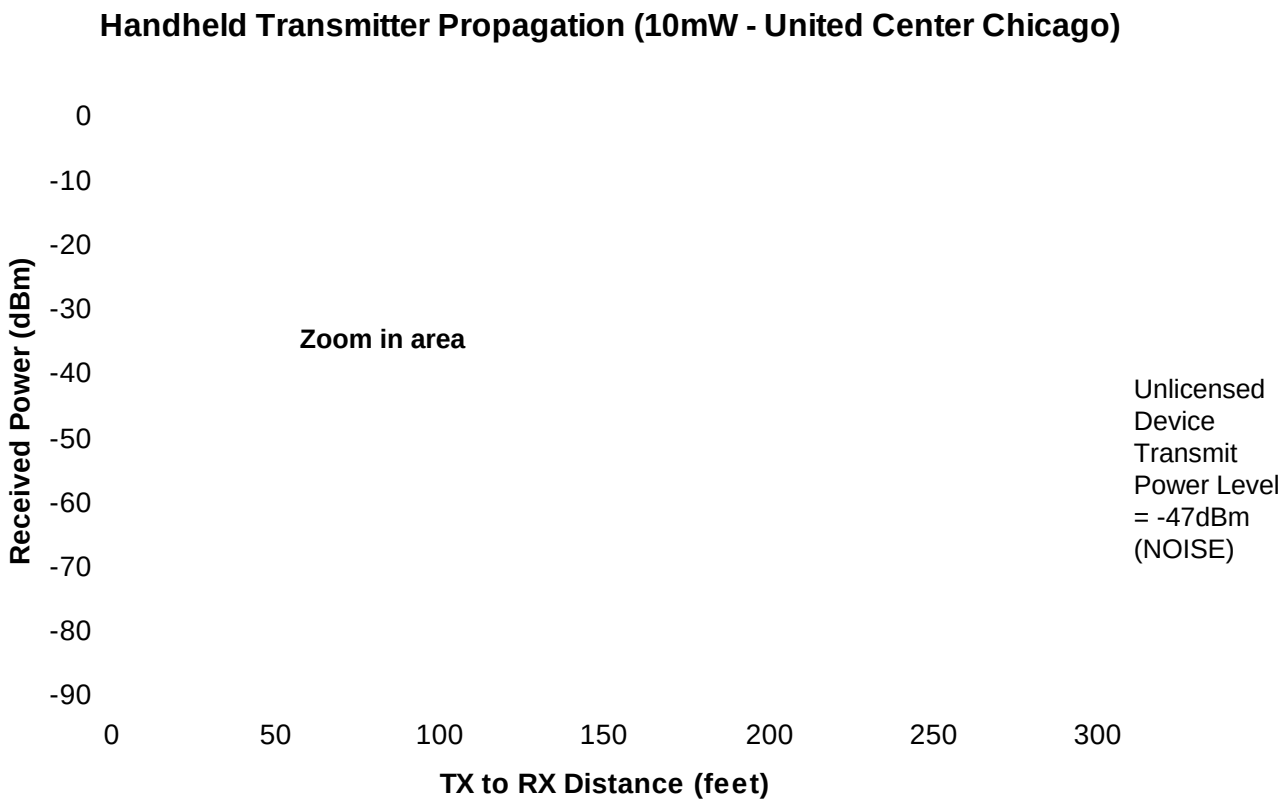
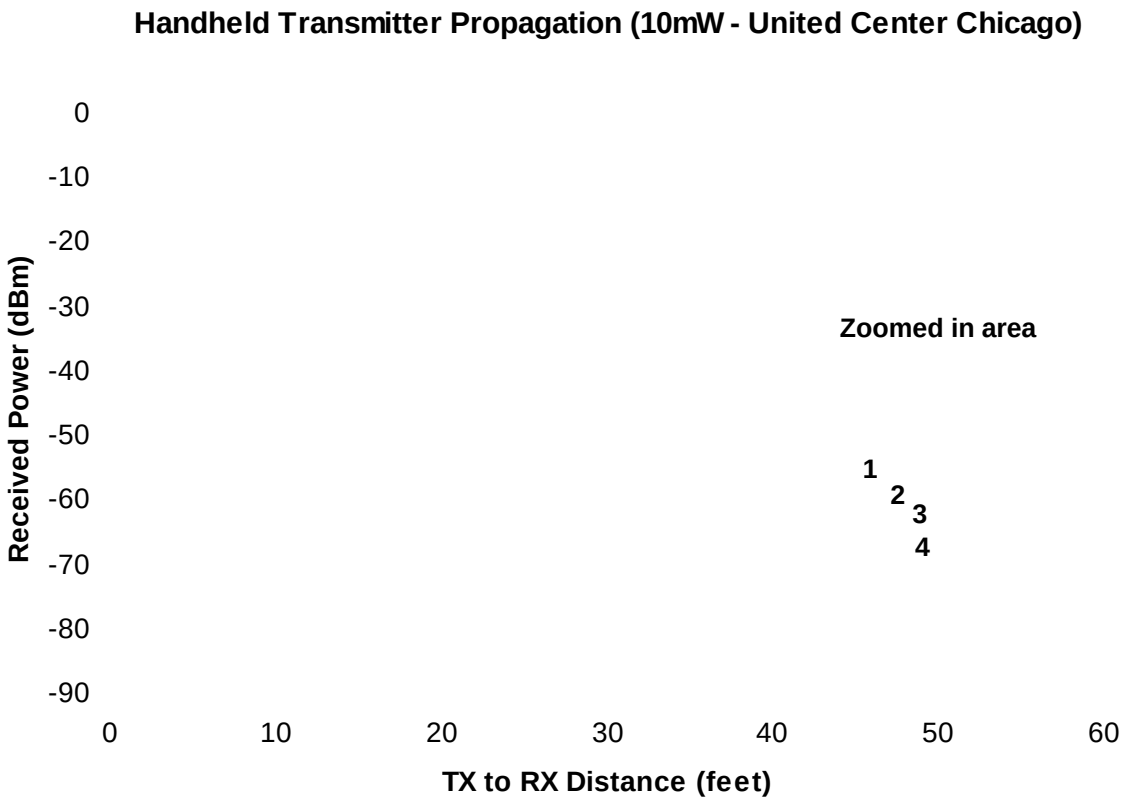
Shure Demonstration

Locate the Google baseline test within real microphone propagation data taken at the United Center in Chicago (Microphone = -56.1dBm, Unlicensed Device = -47dBm)



Shure Demonstration

Then pick 3 other S/N values that are observed on a typical signal strength curve in the United Center data



TEST S/N LEGEND:

1 = Baseline (-9.1dB)
2 = -12.1 dB
3 = -15.1 dB
4 = -19.1 dB

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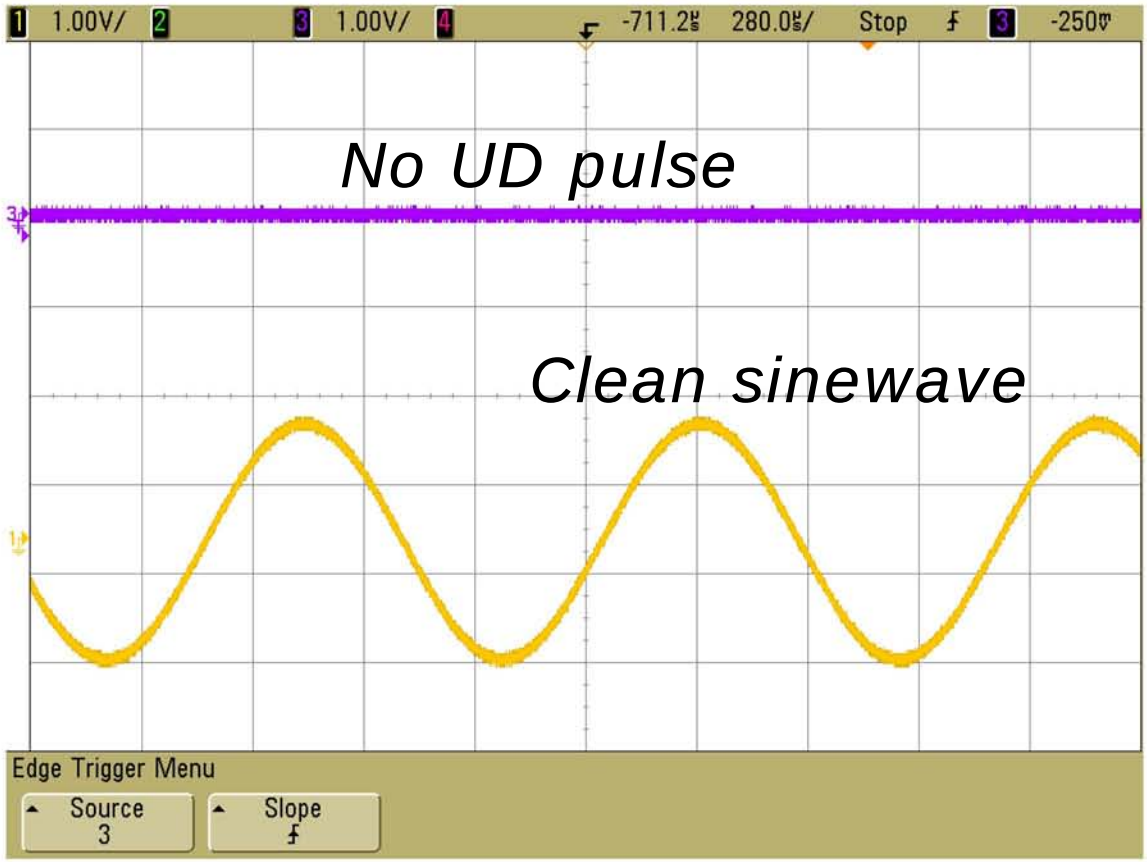
1kHz Tests

First, run the test with no Unlicensed Device interference pulse present and record the clean microphone output.

No interference: S/N = INF.

(S = Microphone, N = Unlicensed device)



Digital Oscilloscope Capture

Unlicensed device (UD) TX pulse

Microphone output (1kHz)

Click to play

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Next, turn the Unlicensed Device interference pulse on, at S/N = -9.1dB baseline, and record the distorted microphone output using a digital oscilloscope and sound card.

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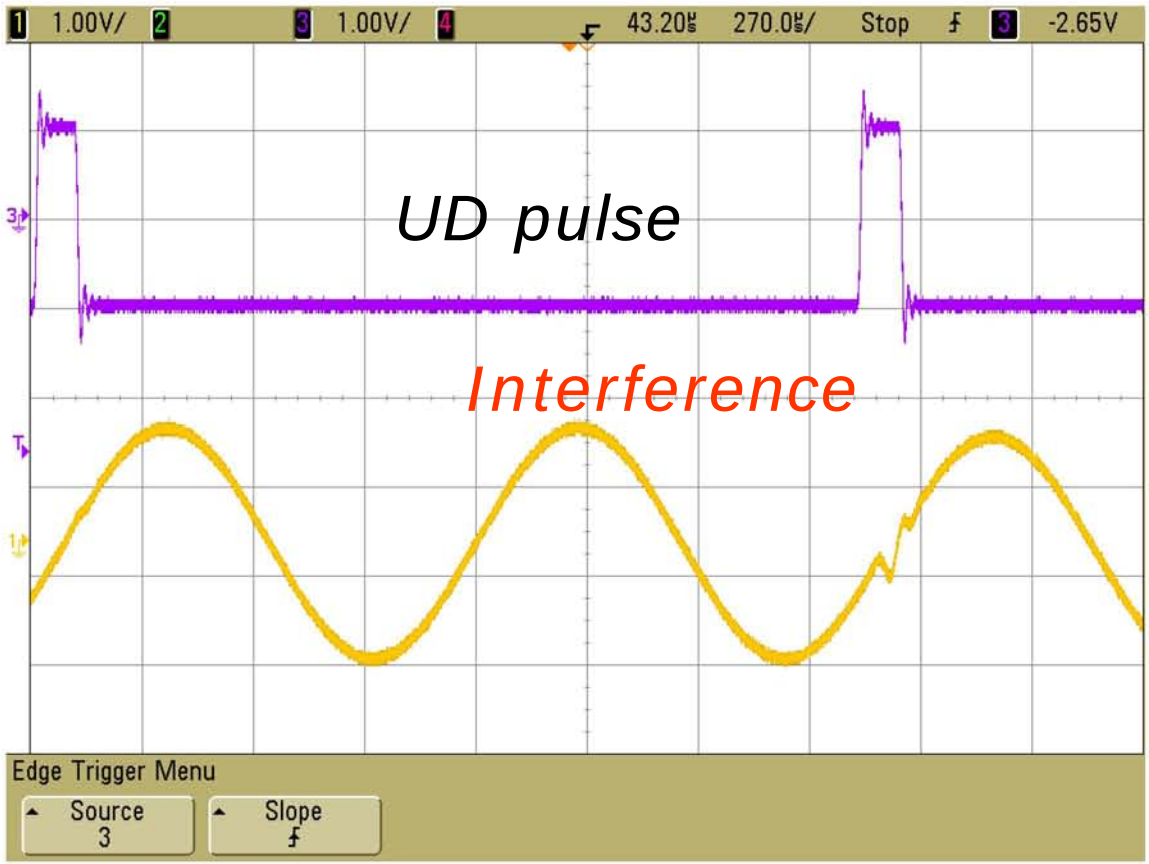
TEST 1: S/N = -9.1dB (Google baseline test)

Pulse Dur. (us)	Pulse Per. (us)	DC (%)
100	2000	5



Digital Oscilloscope Capture

Google claims there is no interference in this test; clearly the UD pulse interferes with the microphone signal

*Interference is demonstrated **visually** on the waveform and **heard** in the distorted audio clip below.*

Click to play

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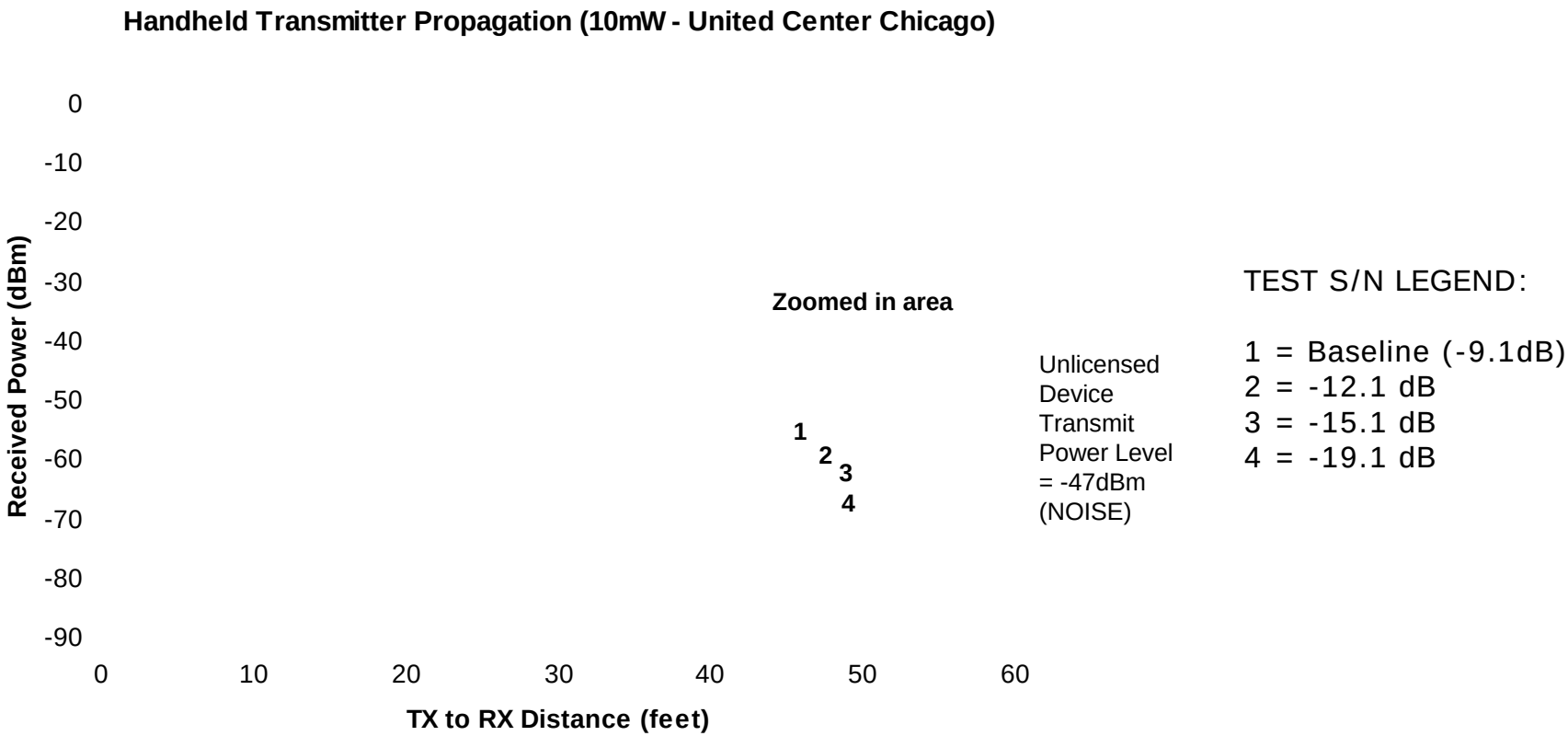
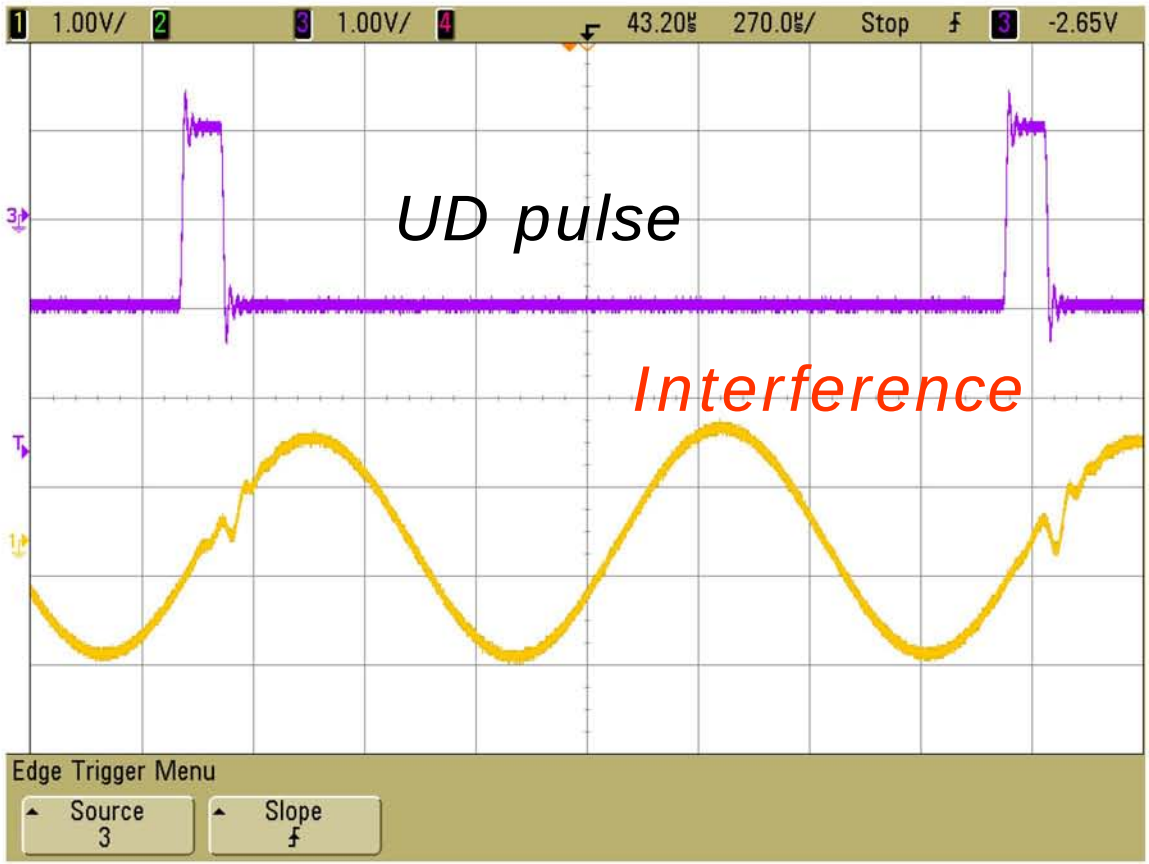
Further testing

To demonstrate the severity of the interference to microphones from burst transmissions, vary the S/N to simulate the microphone being -3dB, -6dB and -10dB weaker.



TEST 2: S/N = -12.1dB (3dB worse S/N)

Pulse Dur. (us)	Pulse Per. (us)	DC (%)
100	2000	5



Digital Oscilloscope Capture

*As the S/N worsens, the level of **interference increases dramatically** as seen visually in the waveform and heard in the further distorted audio clip below.*

Click to play

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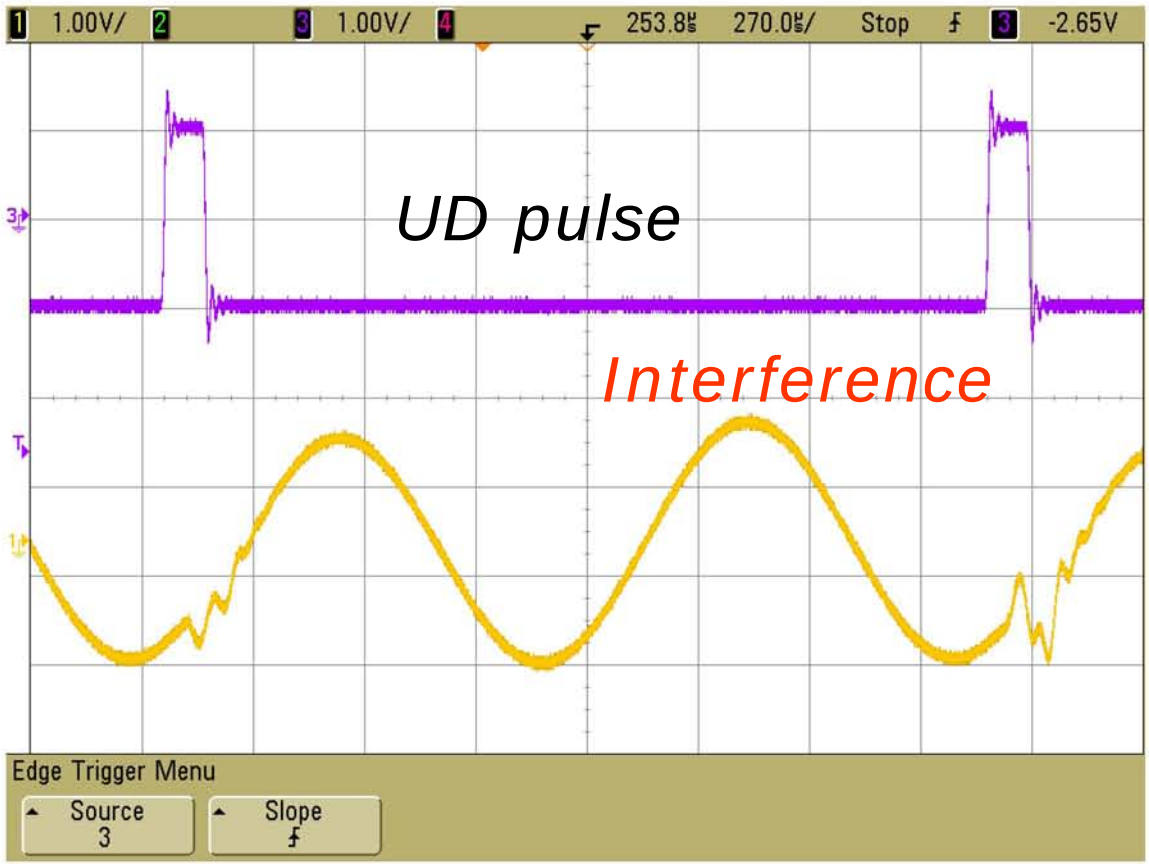
TEST 3: S/N = -15.1dB (6dB worse S/N)

Pulse Dur. (us)	Pulse Per. (us)	DC (%)
100	2000	5



Digital Oscilloscope Capture

*As the S/N worsens, the level of **interference increases dramatically** as seen visually in the waveform and heard in the further distorted audio clip below.*

Click to play

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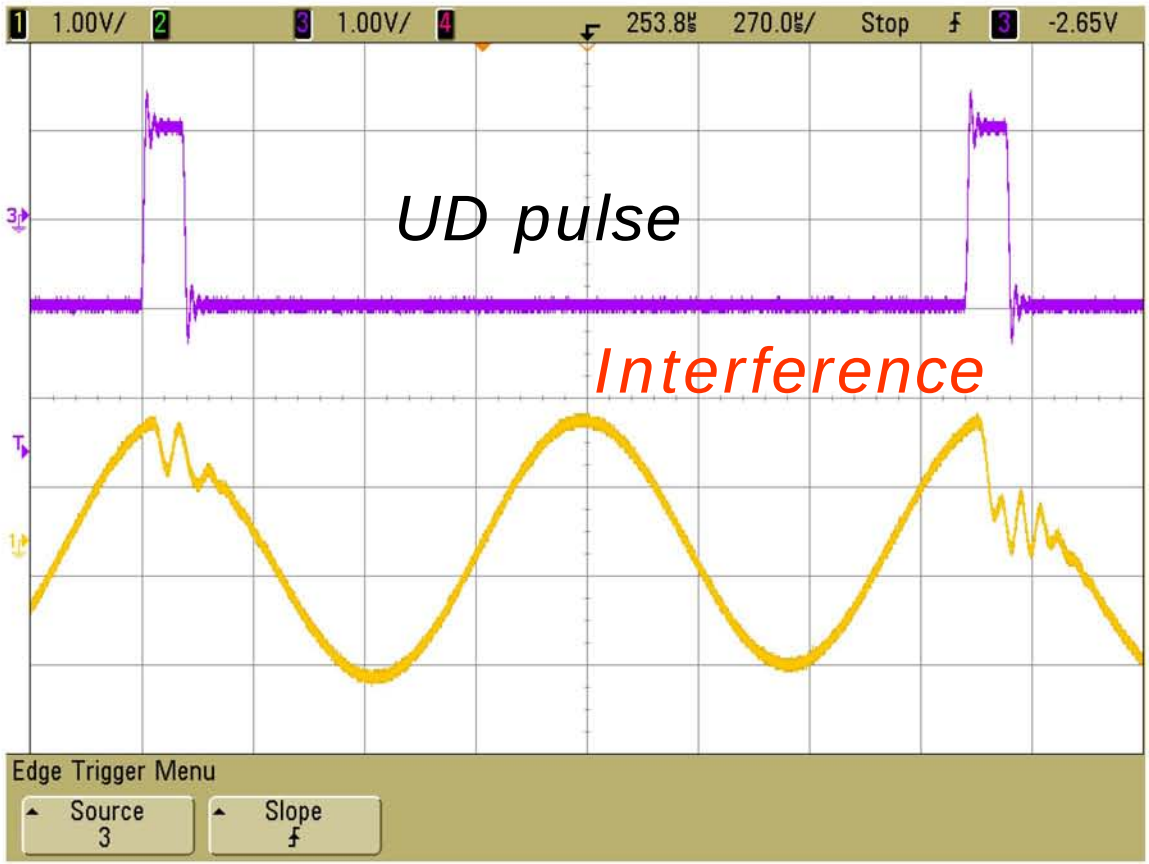
TEST 4: S/N = -19.1dB (10dB worse S/N)

Pulse Dur. (us)	Pulse Per. (us)	DC (%)
100	2000	5



Digital Oscilloscope Capture

*As the S/N worsens, the level of **interference increases dramatically** as seen visually in the waveform and heard in the further distorted audio clip below.*

Click to play

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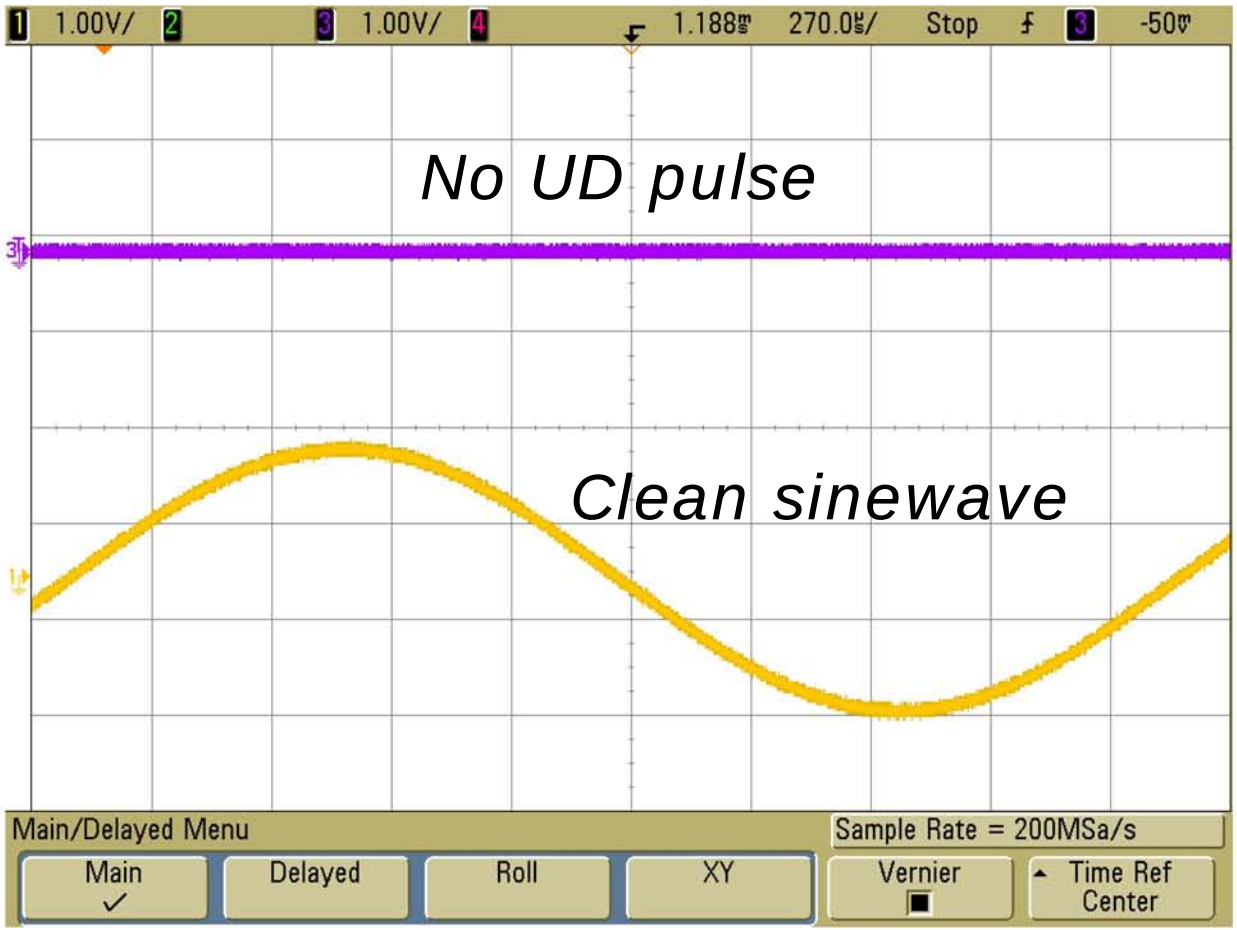
400Hz Tests

First, run the test with no Unlicensed Device interference pulse present and record the clean microphone output.

No interference: S/N = INF.

(S = Microphone, N = Unlicensed device)



Digital Oscilloscope Capture

Unlicensed device (UD) TX pulse

Microphone output (400Hz)

Click to play

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Next, turn the Unlicensed Device interference pulse on, at S/N = -9.1dB baseline, and record the distorted microphone output using a digital oscilloscope and sound card.

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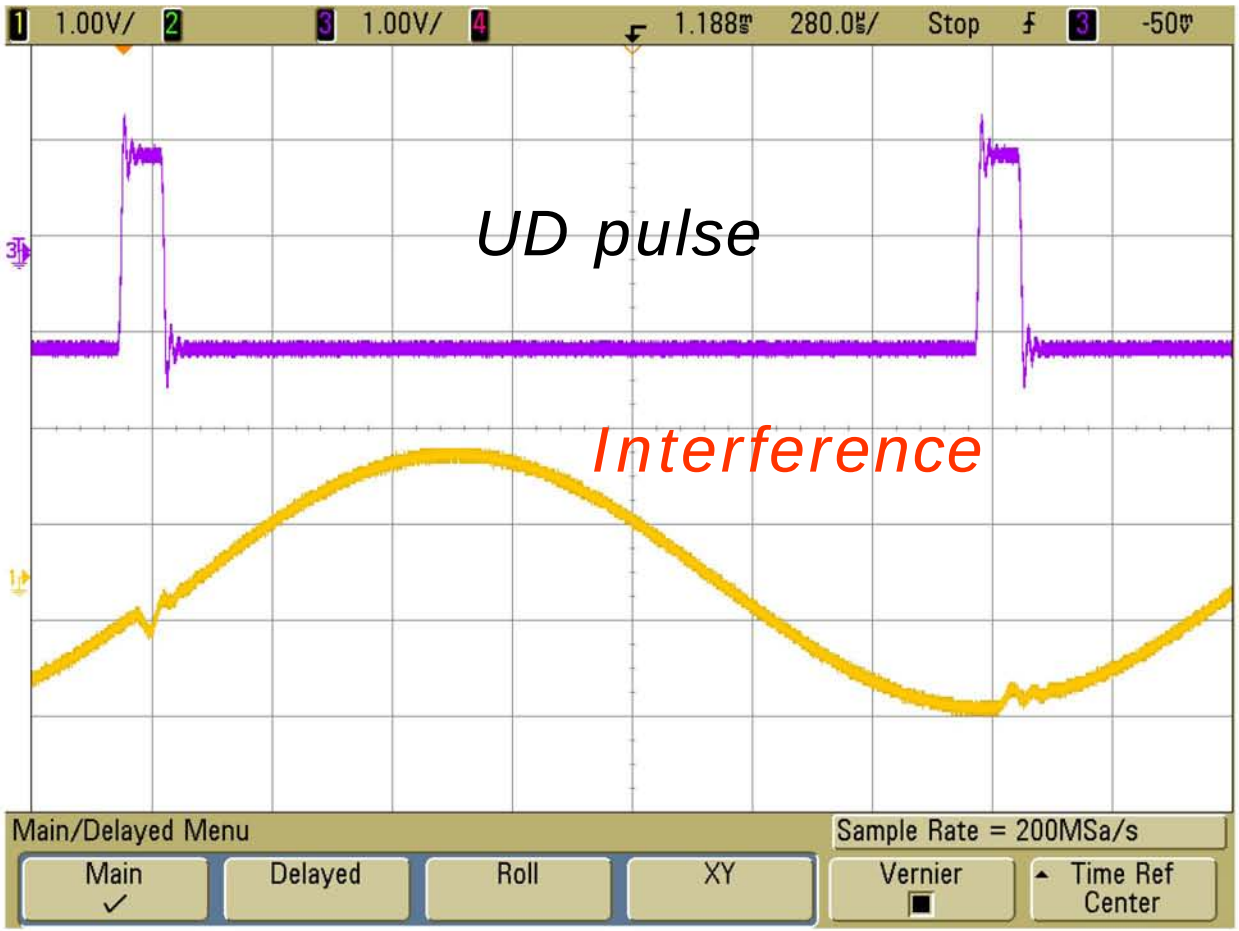
TEST 1: S/N = -9.1dB (Google baseline test)

Pulse Dur. (us)	Pulse Per. (us)	DC (%)
100	2000	5



Digital Oscilloscope Capture

Google claims there is no interference in this test; clearly the UD pulse interferes with the microphone signal

*Interference is demonstrated **visually** on the waveform and in the **distorted** audio clip below.*

Click to play

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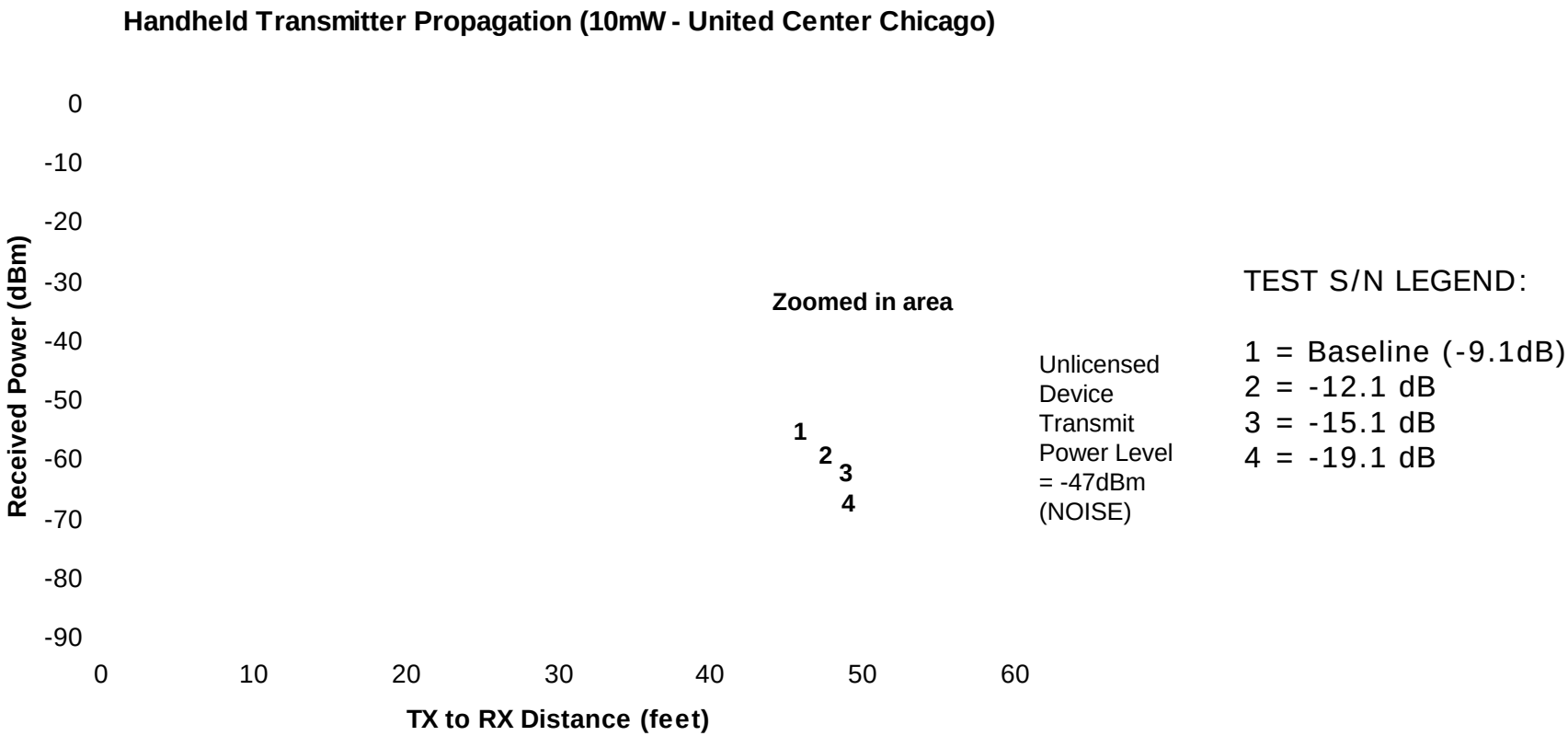
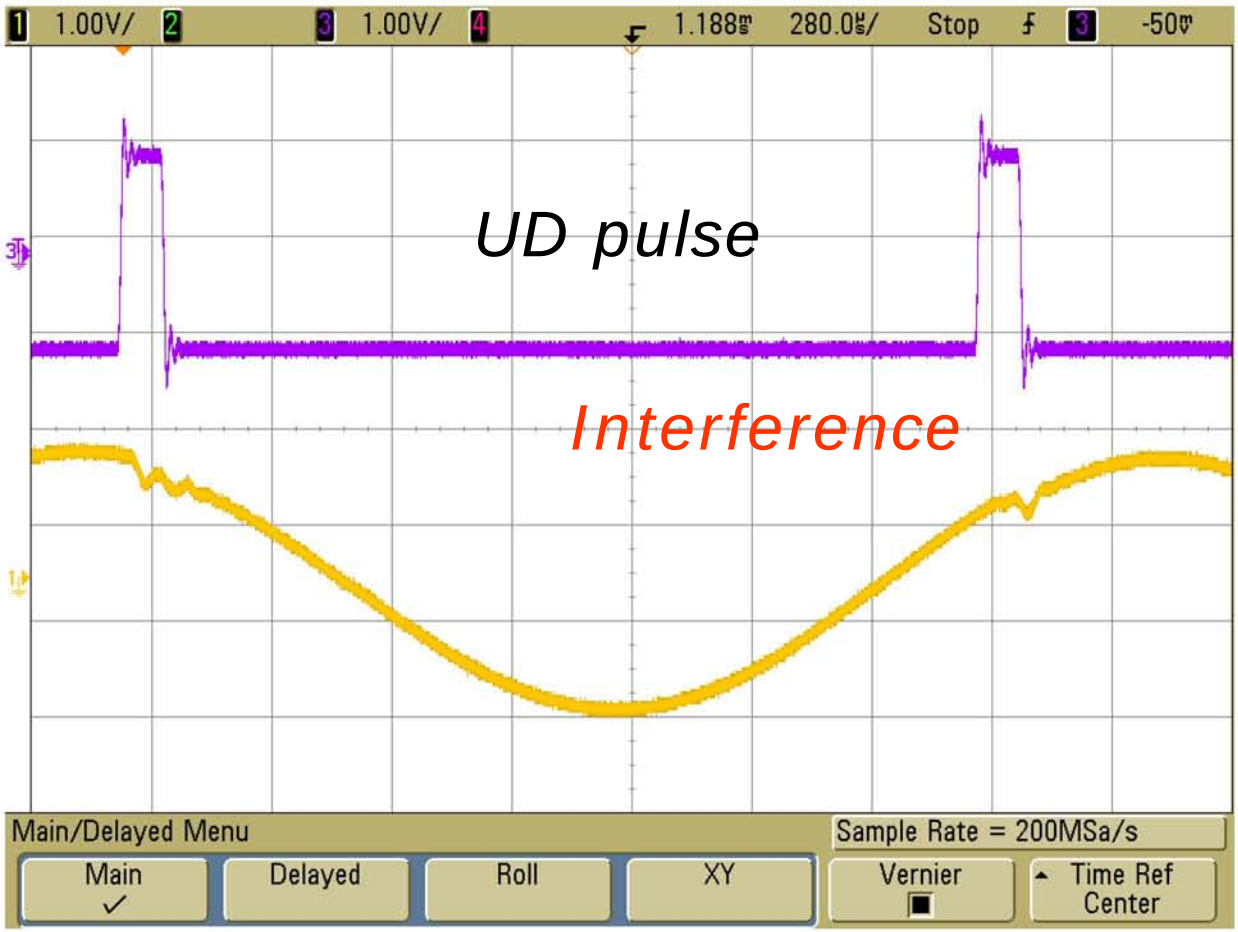
Further testing

To demonstrate the severity of the interference to microphones from burst transmissions, vary the S/N to simulate the microphone being -3dB, -6dB and -10dB weaker.



TEST 2: S/N = -12.1dB (3dB worse S/N)

Pulse Dur. (us)	Pulse Per. (us)	DC (%)
100	2000	5



Digital Oscilloscope Capture

*As the S/N worsens, the level of **interference increases dramatically** as seen visually in the waveform and heard in the further distorted audio clip below.*

Click to play

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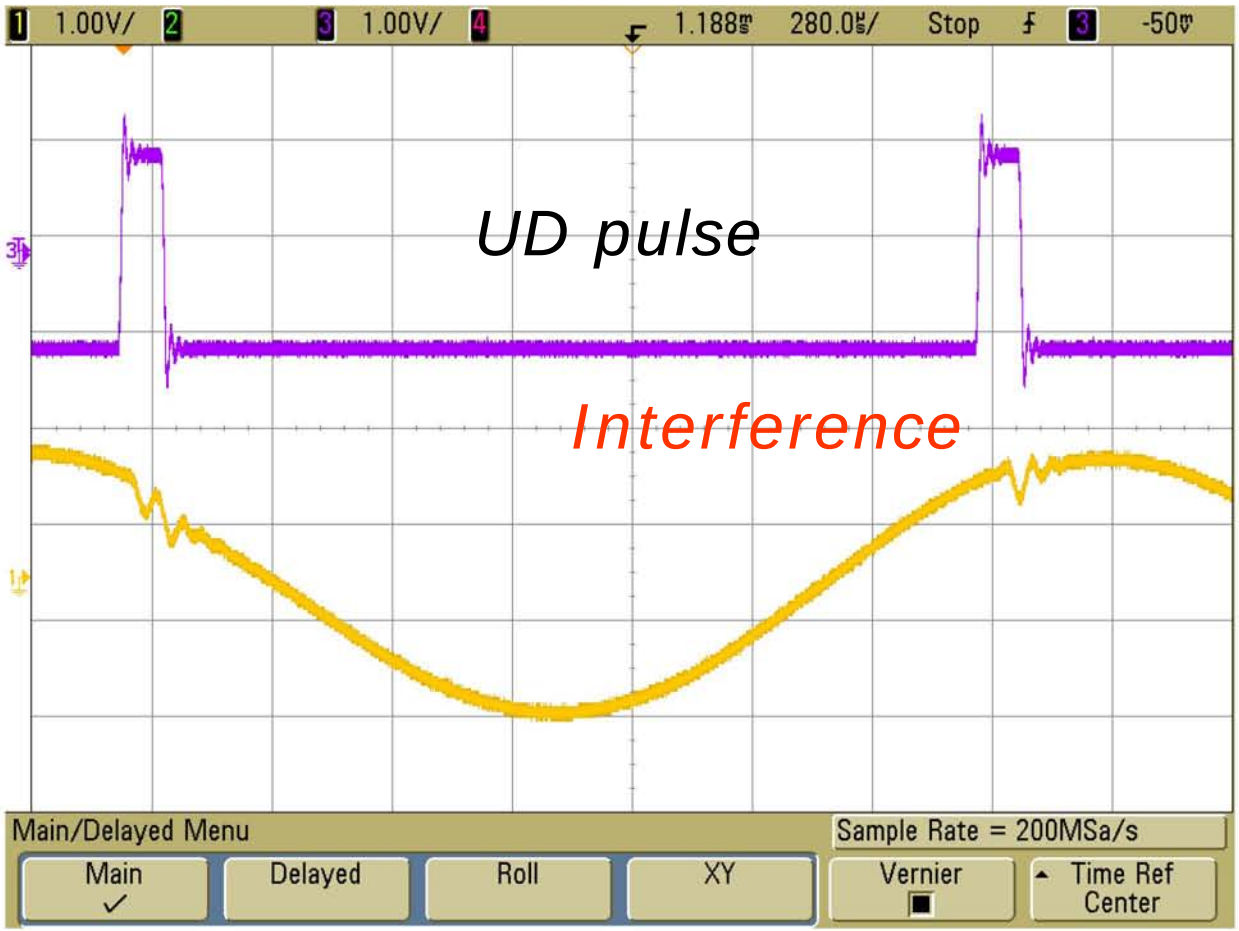
TEST 3: S/N = -15.1dB (6dB worse S/N)

Pulse Dur. (us)	Pulse Per. (us)	DC (%)
100	2000	5



Digital Oscilloscope Capture

*As the S/N worsens, the level of **interference increases dramatically** as seen visually in the waveform and heard in the further distorted audio clip below.*

Click to play

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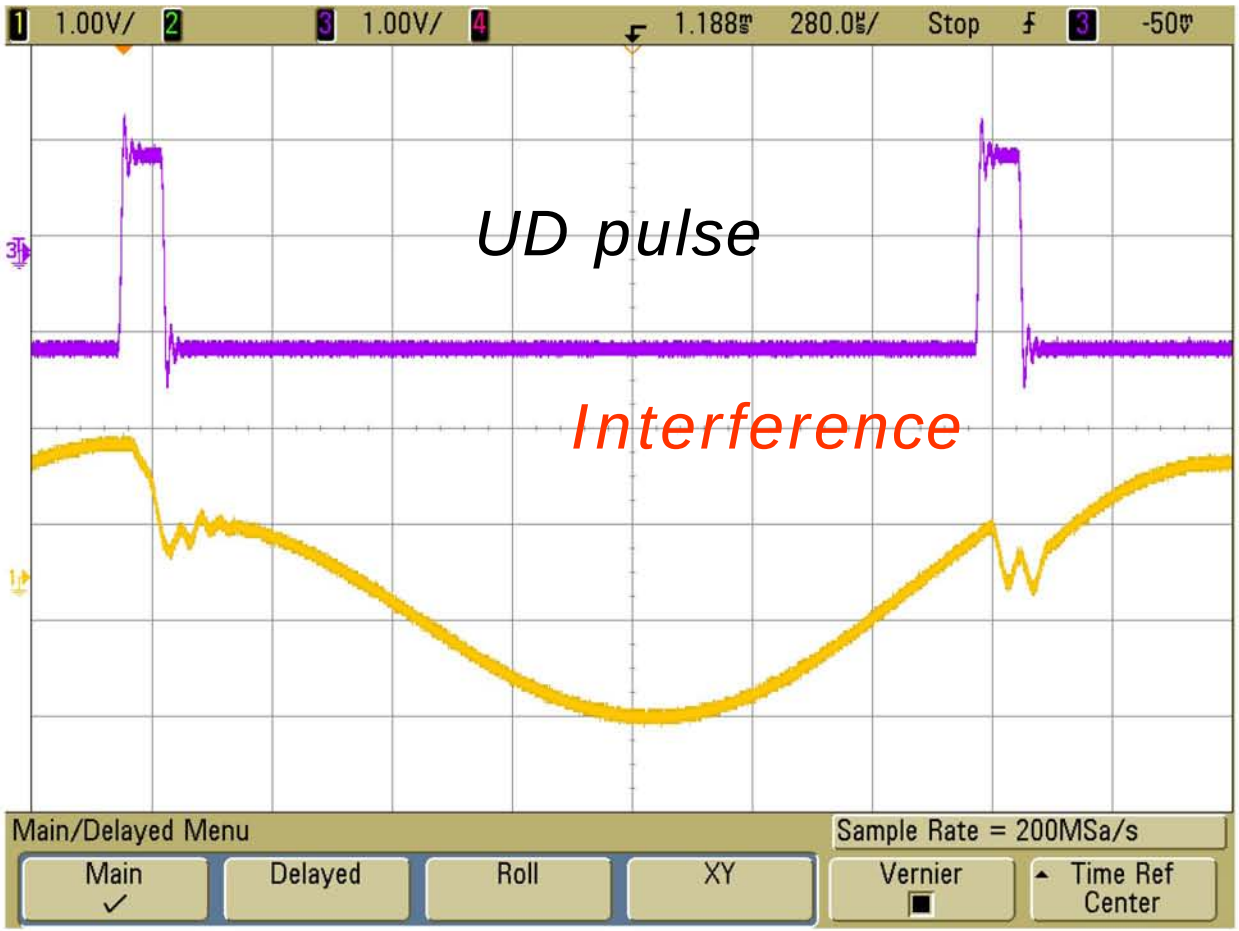
TEST 4: S/N = -19.1dB (10dB worse S/N)

Pulse Dur. (us)	Pulse Per. (us)	DC (%)
100	2000	5



Digital Oscilloscope Capture

*As the S/N worsens, the level of **interference increases dramatically** as seen visually in the waveform and heard in the further distorted audio clip below.*

Click to play

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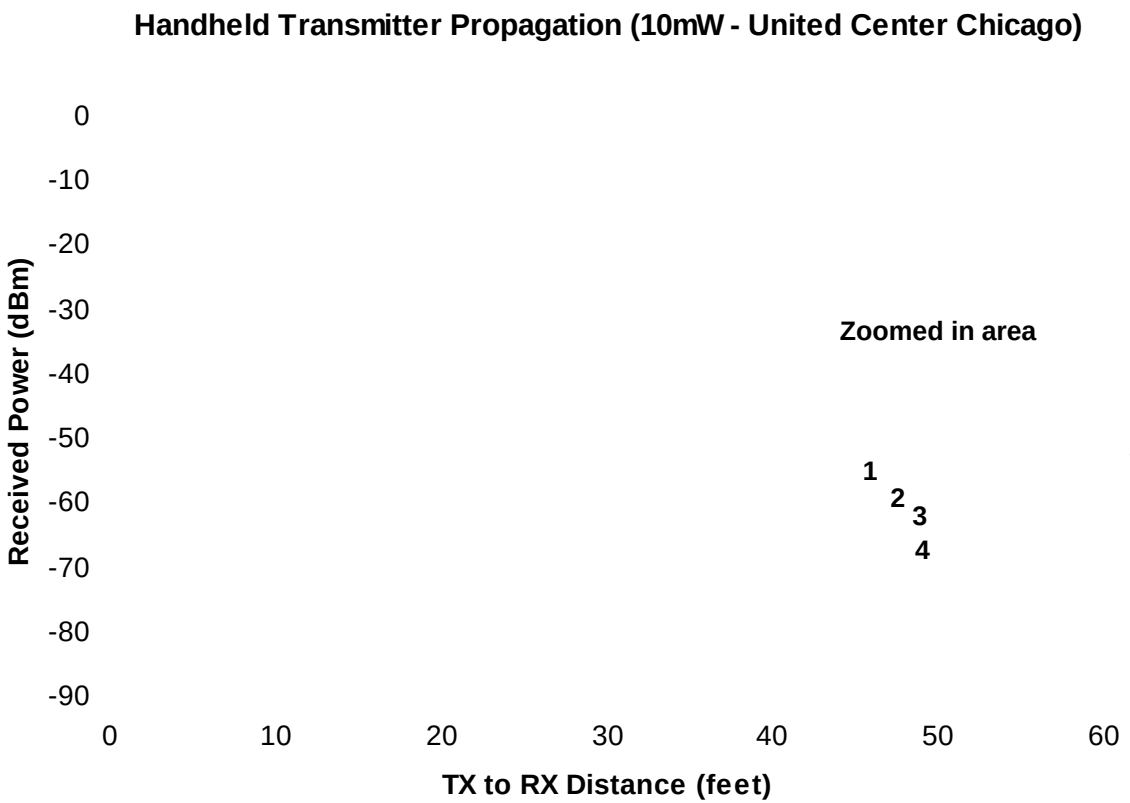
Shure speech burst tests

Run the same test conditions as before, but using speech instead of sinewaves.



TEST S/N LEGEND:

0 = No interference

1 = Baseline (-9.1dB)

2 = -12.1 dB

3 = -15.1 dB

4 = -19.1 dB

Click to play

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Burst Test Conclusions

These test results **clearly** indicate, through visual and audible evidence, the presence of **interference caused by unlicensed device burst transmission** to the wireless microphone.

These results are proven for the S/N=-9.1dB Google case, which is arbitrary considering portable device locations, and other S/N conditions which are observable in normal operation.

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Wireless Microphone Test Issues

Sensing-Related Issues:

It is absolutely critical to incorporate DTV signals in wireless microphone lab testing.

- Prototypes must be tested to determine whether and to what extent they can sense wireless microphone signals in the shadow of high-powered DTV transmissions. Lab testing should include DTV signals in nearby channels (e.g., N+1 and N+2). This should be a minimum requirement to advance to field testing.

- Shure proposed a number of channel configurations for the DTV transmission in lab testing in its November 12, 2007 ex parte filing.

- When DTV signals are incorporated, measurements must be taken at a variety of DTV signal strengths. In the real world unlicensed devices will move around and operate in different environments. Unlicensed Devices must be able to sense wireless microphones regardless of whether adjacent DTV signals are weak or strong. At at a minimum, DTV signals ranging in strength from -20 dBm through -75 dBm should be tested.

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Wireless Microphone Test Issues

Sensing-Related Issues:

- At a minimum, tests should be conducted with wireless microphone signals at -116 dBm.

- Tests should be run to measure at -120 or even -125 dBm. Certain prototype manufacturers indicate their devices sense reliably at -120 dBm.

- The OET Test Plan only proposes wireless microphone tests modulated at 1000 Hz tone at 24 kHz deviation and without modulation. That will not give a complete performance picture. These prototypes must be able to sense wireless microphones using a range of modulation schemes. Even in round one, the FCC tested two different schemes (1000 Hz/24 kHz and 2500 Hz/40 kHz). Wireless microphones should be tested modulated with a white noise source and digital wireless microphones tested with digital modulation.

- During the last round of tests the prototype that had limited success detecting wireless microphones in a sterile setting failed to catch signals near the edge of the channel. The recent Test Plan does not specify how "near“ the edge testing will occur. Prototypes must be tested to detect wireless microphone signals 0.2 MHz from the edge or even closer.

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Wireless Microphone Test Issues

Unlicensed Device Transmitter Interference-Related Issues:

- Unlicensed Devices must have minimal spectral density to avoid creating intermodulation in adjacent channels. How will the tests measure EIRP?

- EIRP must be reduced proportionally when these devices operate in less than a full 6 MHz channel. How will the tests measure the effects of reducing the bandwidth available to an Unlicensed Device in a particular channel?

- How are DTV signals going to be incorporated in the transmission tests? The test should reflect the real world where wireless microphones will encounter Unlicensed Devices and DTV signals simultaneously. To measure an Unlicensed Device's interference potential lab testing should include a variety of combinations where Unlicensed Devices and DTV transmissions are in close proximity to each other (e.g., UD +1 and DTV transmission -1).

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Field Testing

Shure stands ready to support real-world field testing of unlicensed devices and wireless microphones at the request of the FCC

Venue options include:

- NBA Basketball All Star Game and Finals (February / April)
- NCAA Basketball Tournament (March / April)
- MLB Baseball (April)

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